BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : C06B 45/04, 25/34, F42B 1/02 | A1

(11) International Publication Number: WO 98/49123

(43) International Publication Date: 5 November 1998 (05.11.98)

(21) International Application Number: PCT/SE98/00775

(22) International Filing Date: 28 April 1998 (28.04.98)

(30) Priority Data:
9701622-4 29 April 1997 (29.04.97) SE

(71) Applicant *(for all designated States except US)*: FÖRSVARETS FORSKNINGSANSTALT [SE/SE]; S-172 90 Stockholm (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: LANGLET, Abraham [SE/SE]; Surbrunnsgatan 33, S-113 48 Stockholm (SE). ÖSTMARK, Henric [SE/SE]; Bergmarksvägen 2, S-141 41 Huddinge (SE).

(74) Agent: FÖRSVARETS MATERIELVERK; Patentenheten, S-115 88 Stockholm (SE).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: MELT CAST CHARGES

(57) Abstract

The invention relates to a method of manufacturing melt cast charges, e.g. shaped charges, comprising suspension of an explosive component in a molten component serving as a matrix. The invention is characterised in that ADN (ammonium dinitramide) is used as a matrix. The invention also concerns a melt cast charge comprising a matrix of ADN, in which an explosive has been suspended, selected from the group consisting of RDX, HMX, HNIW and mixtures thereof.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

Melt Cast Charges

The invention relates to a method of manufacturing melt cast charges comprising suspension of an explosive component in a molten component serving as a matrix, and new charges manufactured in accordance with the method.

Melt cast charges are commonly used as explosive charges in shells and mines. Casting is a simple and inexpensive method of manufacturing also charges of a complicated design, e.g. shaped charges, directly in a shell body. Melt cast charges are also relatively easy to scrap by melting out the charge.

TNT (2,4,6-trinitrotoluene) is the explosive which has mainly been used in melt cast charges. TNT is stable, insensitive and has a low melting point (80°C), but has relatively poor performance and a strongly negative oxygen balance (-73.9%). Explosives having higher performance, such as RDX and HMX, have therefore been suspended in molten TNT, which thus has served as a matrix, thereby obtaining castable mixed explosives. Also a number of other products can be mixed with molten TNT to obtain castable explosive charges for special purposes, e.g. aluminium powder for charges having high efficiency.

One object of the present invention is to provide melt cast charges with improved performance. A further object is to use a new matrix which replaces TNT in the manufacture of melt cast charges, but which at the same time allows essentially the same processes and process equipment to be used in the manufacture of the charges.

According to the invention, ADN (ammonium dinitramide) is used as a matrix. The preparation of ADN is disclosed in e.g. WO 91/19669, WO 91/19670, WO 93/16002 and WO 97/06099.

The invention also relates to a melt cast charge comprising a matrix of ADN, in which an explosive has been suspended, selected from the group consisting of RDX, HMX, HNIW and mixtures thereof.

HNIW, or CL-20 as it is also referred to, is hexanitrohexaazaisowurtzitane. A method of preparing HNIW is disclosed in e.g. WO 97/00873. HNIW has no melting point and decomposes at about 230°C.

Melt cast charges of mixed explosives, in which TNT is used as a matrix, are well known and have long been used in military applications. Examples of such mixed explosives are TNT/RDX (Cyclotol, Hexotol, Comp. B, HT); TNT/HMX (Octol); TNT/RDX/Al (Hexotonal, Torpex, Trialene, HTA, HBX-1, HBX-3, H-6); TNT/HMX/Al (Octonal, HTA-3); TNT/RDX/HMX; TNT/RDX/HMX/Al.

According to the invention, ADN (ammonium dinitramide) can replace TNT as a matrix in such charges and result in a mixed explosive with improved performance. TNT has a melting point of about 80°C and ADN a melting point of 92°C. The difference in melting point is not greater than to allow the use of essentially the same manufacturing processes when the charges are manufactured by using the new matrix.

The detonation performance for pure ADN is somewhat lower than for TNT, but mixtures of ADN and HMX, RDX, HNIW etc. result in considerably higher performance than do mixtures of the corresponding explosive and TNT.

The new method is especially well suited for manufacturing shaped charges, where the melt/cast technique has great advantages while at the same time it is desirable to achieve higher performance of the charges.

Theoretical calculations of detonation performance in shaped charge applications for different mixtures have been carried out by using the program Cheetah, the detonation performance for HMX being used as a basis of calculation and being set to 100%. The result is shown in the following Table:

Explosive	Mixture, weight%/weight%	Performance, % of HMX
TNT/RDX	30/70	80
TNT/HMX	30/70	85
ADN/RDX	30/70	95
ADN/HMX	30/70	101
ADN/HNIW	30/70	112

A mixture of ADN/HMX 30/70 has the same performance as pure HMX, i.e. HMX can be melt cast without loss of performance by using ADN as a matrix.

The performance values in the Table relate to mixtures, i.e. for ADN/HNIW (ADN/CL-20) if HNIW is suspended in molten ADN. As described in Swedish Patent Application 9701394-0, HNIW can also be dissolved in molten ADN, thereby obtaining a complex of ADN and HNIW. The performance for the complex is higher than for the mixture.

In the charges, aluminium powder and other additives can be mixed in the same way as is known from the manufacture of charges using TNT as a matrix. When aluminised charges are manufactured, the explosive can first be granulated with aluminium powder, for instance as described in US 4,376,083, before being mixed with the matrix.

The invention will now be described by way of Examples.

Example 1

3 g ADN were melted in a small steel cup provided with a thermostat and internally coated with Teflon. The thermostat was set at 105°C. 6 g HMX (200 μm) were added and mixed with the melt. A small stainless steel anchor was dropped into the mixture. The sample was cooled by setting the thermostat at 94°C for about 7 min and then switching it off completely. When the sample had cooled, it was carefully withdrawn from the cup by means of the anchor.

The test was repeated while adding RDX and mixtures of HMX and RDX to molten ADN.

The samples were analysed by DSC. No complex formation or exotherms owing to compatibility problems could be observed. Moreover, no change could be noted, either of the ADN matrix or of the admixed explosives when dividing the cast samples.

Example 2

3 g ADN were melted in the same way as in Example 1, and 6 g HNIW were added and mixed with the melt. The mixing was carried out relatively quickly to avoid that

HNIW dissolved in the melt to any considerable extent. The sample was cooled by shutting off the thermostat.

The sample was analysed by DSC. At 92 °C, the ADN phase melted while the HNIW crystals seemed to be unaffected.

Claims:

1. A method of manufacturing melt cast charges, comprising suspension of an explosive component in a molten component serving as a matrix, characterised in that the molten component is ADN.

2. A method as claimed in claim 1, characterised in that the charges are shaped charges.

3. A melt cast charge, characterised in that it comprises a matrix of ADN, in which an explosive has been suspended, selected from the group consisting of RDX, HMX, HNIW and mixtures thereof.

4. A melt cast charge as claimed in claim 3, characterised in that it contains aluminium powder.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/00775

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C06B 45/04, C06B 25/34, F42B 1/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C06B, C06D, F42B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

STN: REGISTRY, CA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5468313 A (INGVAR A. WALLACE, II ET AL), 21 November 1995 (21.11.95), column 1, line 9; column 3, line 16 - line 23; column 4, line 10 - line 29, column 4, line 31 - line 47; column 4, line 48 - line 58	1-4
A	WO 9706099 A1 (FÖRSVARETS FORSKNINGSANSTALT), 20 February 1997 (20.02.97), claims 1,9	1-4
A	WO 9700873 A1 (THIOKOL CORPORATION), 9 January 1997 (09.01.97), column 1, line 12 - line 27, claim 1	1-4

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 August 1998	10 August 1998 (10.08.98)
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bengt Christensson Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/00775

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4376083 A (KARE ULSTEEN), 8 March 1983 (08.03.83), claim 1 -- --------	1-4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 98/00775

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5468313 A	21/11/95	NONE	
WO 9706099 A1	20/02/97	AU 6539696 A	05/03/97
		EP 0843647 A	27/05/98
		NO 980534 A	06/02/98
		SE 9502783 D	00/00/00
		SE 9503326 A	09/02/97
WO 9700873 A1	09/01/97	AU 6180896 A	22/01/97
		NO 975869 A	12/12/97
		US 5723604 A	03/03/98
US 4376083 A	08/03/83	CA 1172454 A	14/08/84
		EP 0035376 A,B	09/09/81
		SE 0035376 T3	
		PT 72476 B	04/02/82